Quantum Approach for Orbital Angular Momentum of Channeling Radiation from 255 MeV Electrons in Thin Si Crystal

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The radiation of relativistic electrons in helical undulator carry orbital angular momentum (OAM). This fact was theoretically predicted [1] and experimentally proved [2]. The undulator radiation from 917 MeV electrons contains the photons with energy of 99 eV and OAM $\pm\hbar$, see [2]. However, charged particles moving along a helical trajectory produce radiation carring OAM [3]. One more example of the trajectory of such a type is the rosette trajectory of a charged particle at axial channeling regime.

Here, using the developed code BCM-2 [4] and the general formula for the probability of radiation of a twisted photon by a classical current derived in [5], we calculate the distribution of photons of channeling radiation over its OAM projection and the density of the average number of photons carrying OAM against the photon energy. The calculations are carried out for the initial electron beam energy 255 MeV (SAGA-LS) and thin 10 μm Si crystal to avoid the dechanneling effects.

The comparison of the results with the ones obtained using the semi-classical approach [6-8] is performed. The proposed scheme for production of radiation carrying the OAM allows one to generate the twisted photons with much higher energies as compared with the scheme based on using the undulator radiation [1, 2].

References

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